Biochemistry

Carbohydrates

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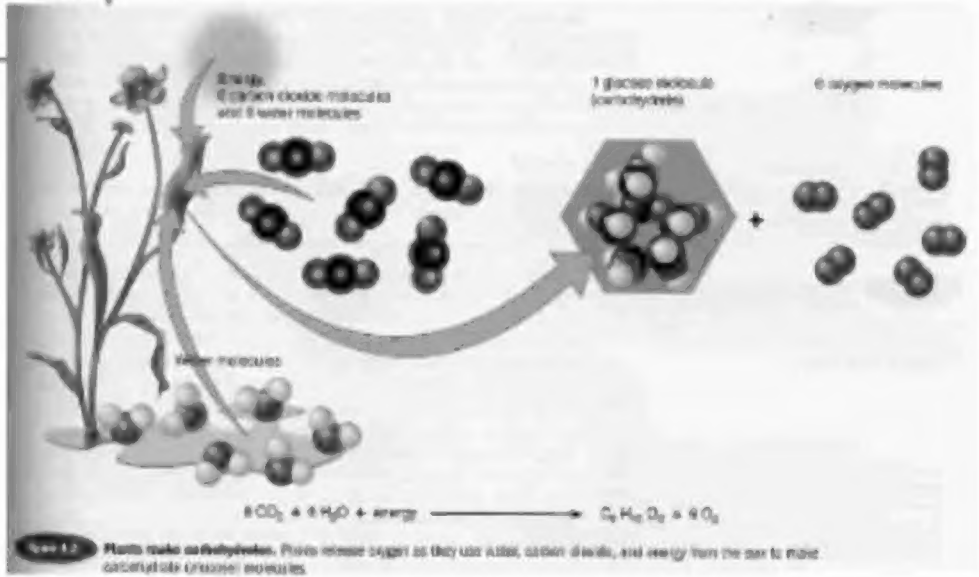
Introduction and Definition

- ✓ **Carbohydrates or Saccharides**
- ✓ **(Greek Sakcharon meaning "Sugar")**
- ✓ **Organic compounds composed of Carbon, Hydrogen and oxygen.**

CARBOHYDRATES ARE POLYHYDROXYL ALCOHOLS WITH POTENTIALLY ACTIVE CARBONY GROUPS WHICH MAY BE EITHER AN ALDEHYDE OR KETONE GROUP. THEY ALSO CONTAIN THOSE COMPOUNDS, WHICH YIELD THEM ON HYDROLYSIS.



Monosaccharides: Single Sugars

Glucose

- ✓ carbohydrate form used by the body, referred to as "blood sugar"
- ✓ basic sub-unit of other larger carbohydrate molecules
- ✓ found in fruits, vegetables, honey

Glucose

Fructose

- ✓ sweetest of the sugars
- ✓ occurs naturally in fruits & honey, "fruit sugar"
- ✓ combines with glucose to form sucrose

Fructose

Galactose

- ✓ combines with glucose to form lactose, "milk sugar"

Galactose

- ✓ Carbohydrates are found on the surface of cells where they act as "road signs" allowing molecules to distinguish one cell from another.

- ✓ ***ABO blood markers*** found on red blood cells are made up of carbohydrates. They allow us to distinguish our body's blood type from a foreign blood type.

- ✓ Carbohydrates in our body prevent blood clots. They are also found in our genetic material.

Types of Carbohydrates

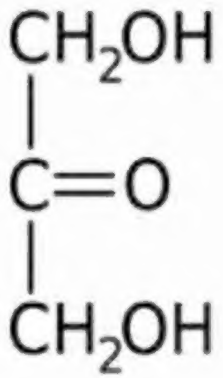
Simple Carbohydrates

- ✓ monosaccharides
- ✓ disaccharides

Complex Carbohydrates

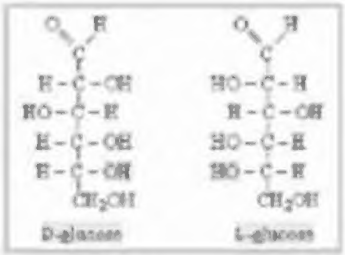
- ✓ oligosaccharides
- ✓ polysaccharides
  - ❖ glycogen
  - ❖ starches
  - ❖ fibers

- ✓ All molecules except Dihydroxyacetone contain one r more chiral carbon units in the structure
- ✓ A formula may used to find how much isomer can be made according to chirality condition. **Fischer Projection formula**
- ✓ That is Numbers of Isomers = 2^n (Where n is number of chiral units)

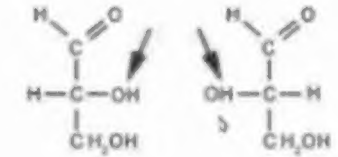


For example

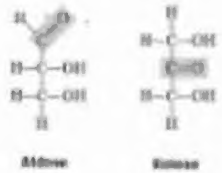
Glyceraldehyde has one chiral (central) unit, so 2^1= 2 isomers.
Glucose has 4 chiral units , so 2^4 = 16 Isomers. (8 D form, 8 L forms)



Structural aspects of Monosaccharides



Stereoisomerism



- ✓ It is an important characteristic of Monosaccharides.
- ✓ These re the compounds with same structural formula with different configurations.
- ✓ A carbon attached with different atoms / groups is known as asymmetric. Also called Chiral compound.
- ✓ A molecule is chiral if its two mirror image forms are not superposable upon one another. ASYMMETRICIA molecule is achiral if its two mirror image forms are superposable. SYMMETRICI
- ✓ This property determines the possible creation of isomers.

Monosaccharide further classified on the basis of functional group and number of carbon atoms present in their structure

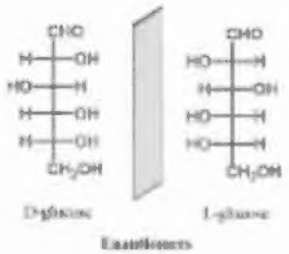
On the basis of no. of carbon atom

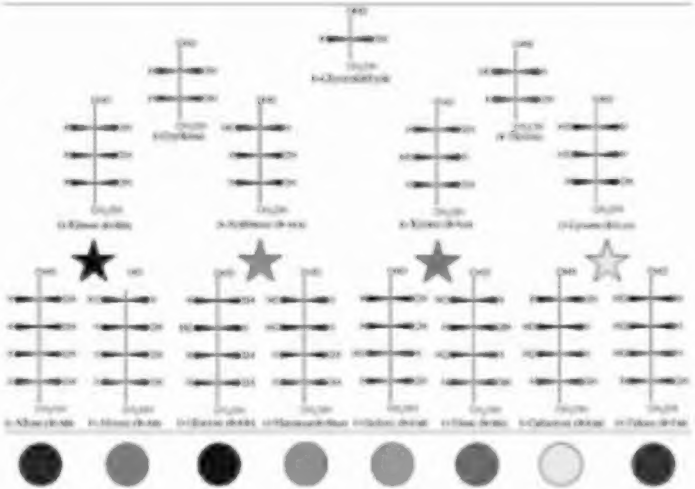
On the basis of functional group

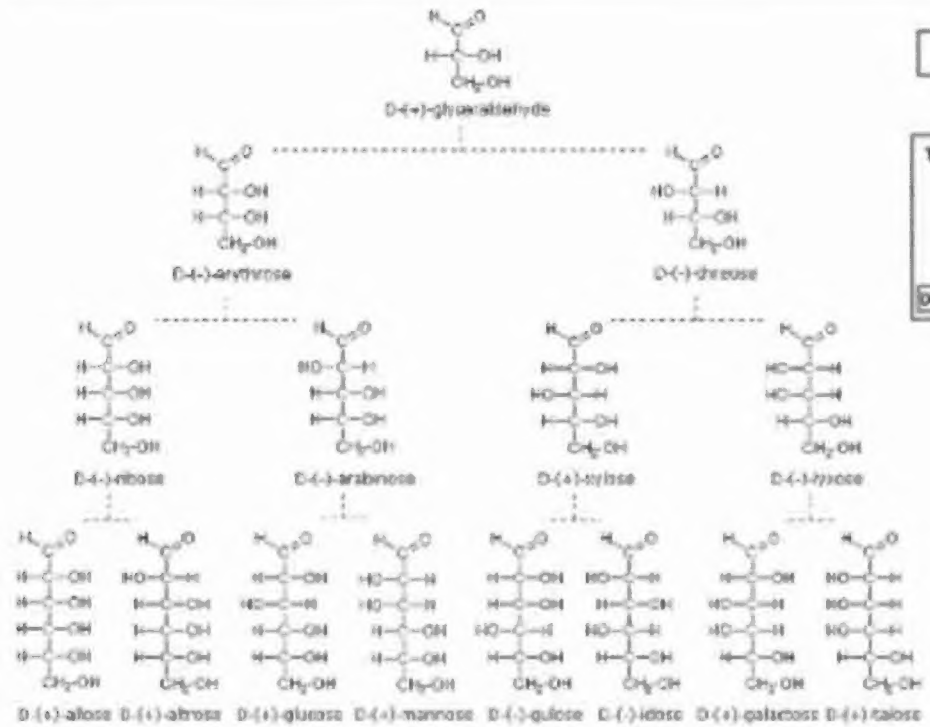
No. of carbon atom	Generic name	ALDOSE	KETOSE
3	Trioses	Aldotriose e.g. glyceraldehyde	Ketotriose e.g. Dihydroxyacetone
4	Tetroses	Aldotetrose e.g. Erythrose	Ketotetrose e.g. Erythrulose
5	Pentoses	Aldopentoses e.g Arabinose, Xylose, Ribose	Ketopentoses e.g. Xylulose, Ribulose
6	Hexoses	Aldohexose e.g. Glucose, Galactose, Mannose	Ketohexose e.g. Fructose

D and L Isomers (Enantiomers)

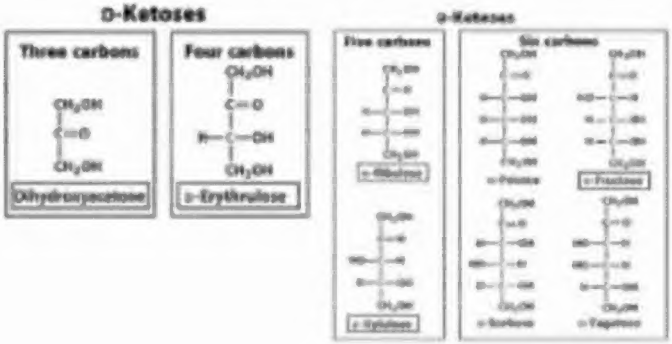
- ✓ The D and L Isomers are the mirror images of each other.
- ✓ The spatial orientation of -H of –OH on C_5 (glucose) determines, whether the sugar is D isomer or L Isomer.
- ✓ If OH group is at right side denotes D isomer and at left shows L isomer.
- ✓ Mostly naturally occurring monosaccharides i mammalian are D configured.
- ✓ Diasteroisomers is used to represent that are not mirror images of another.







Structures of the D-Ketoses

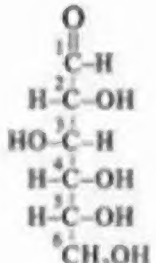


Optical Activity of Sugars

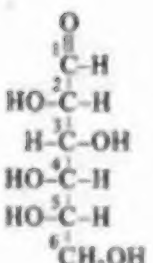
- ✓ This is the property of sugar with asymmetrical carbon atoms.
- ✓ When a beam of polarized light pass through a isomer, it will turn it on left or right side.
- ✓ The terms dexorotatory and levorotatory will be used.
- ✓ A optical isomer may be designated D+ D- L+ L- on its structural relation of glyceraldehyde.
- ✓ D- L- ae based on glyceraldehyde, optical activities may differ.

Racemic Mixture:

- ✓ If the D- L- isomers are present in equal concentrations, known as racemic mixture or DL mixture.
- ✓ It does not have optical activity due cancelation of Dexo and levo activities.



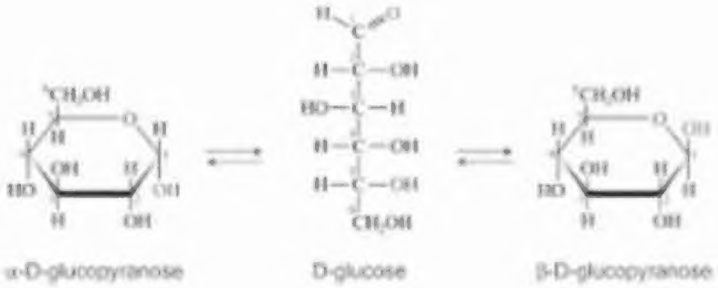
D-Glucose



L-Glucose

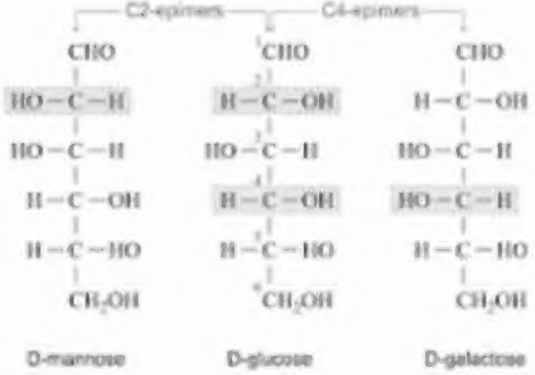
Mutarotation – Anomers

- ✓ Mutarotation is the change in the optical rotation because of the change in the equilibrium between two anomers, when the corresponding stereo-centers interconvert.
- ✓ Cyclic sugars show mutarotation as α and β anomeric forms of D glucose interconvert.
- ✓ The differ from each other in the configuration of Carbon number 1.
- ✓ In case of alpha anomer –OH group held on the opposite side CH_2OH of the sugar ring.
- ✓ Reverse is called B anomer.

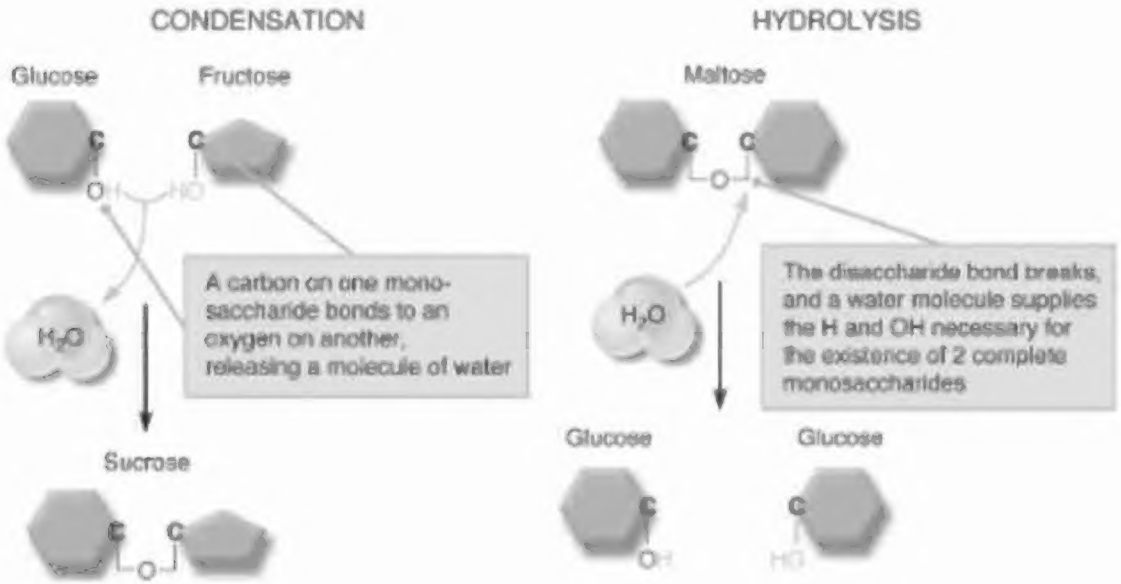


Epimers

- ✓ Epimers are diastereomers that contain more than one chiral center but differ from each other in the absolute configuration at only one chiral center.
- ✓ Thus, 1 and 2 are epimers. In epimers the chiral carbon atoms whose absolute configuration makes the two compounds different are called the epimeric carbons.
- ✓ Suppose two monosaccharides are differ in single carbon atom other than anomer are called epimers of each others.
- ✓ Gulcose and galatose are epimers of each other carbon 4, Glucose and mannose are epimers of each other at carbon 2.



Joining and Cleaving Sugar Molecules



- ✓ Due to such change anomer also differ in physical and chemical properties.

- ✓ Alpha d glucose ===== equilibrium mixture ====== B D glucose
  $+112.2^0$ $+18.7^0$
  Specific Optical rotation.

- ✓ A equilibrium mixture contain 63 % B anomer and 36 % alpha anomer with 1% open chain.

- ✓ In fructose pyranose ring convert o furanose ring till an equilibrium attained.

- ✓ Its specific optical rotation -92^0